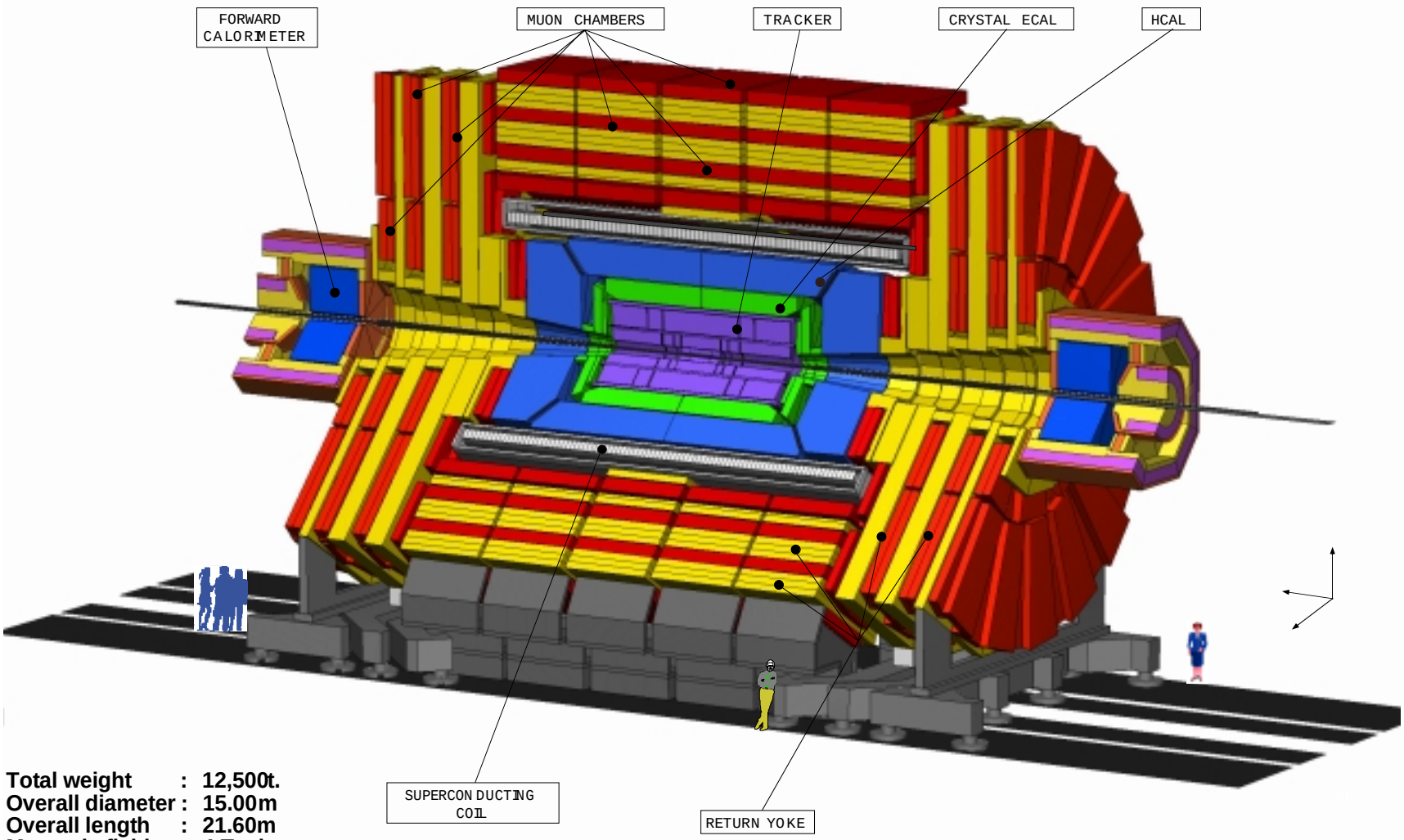
Update on the Status of CMS

- **Magnet (A. Hervé)**
- **Schedule/Milestones/Proposed Work in 2000 (A. Ball)**
- **Tracker Issues**
- **Calorimetry**
- **Muons**
- **Collaboration**
- **Contingency Plans**
- **Budget for 2000 (D. Blechschmidt)**

9th Meeting of CMS RRB
26th October 1999

M. Della Negra
CMS Spokesperson

CMS Detector



Total weight : 12,500t.
Overall diameter : 15.00m
Overall length : 21.60m
Magnetic field : 4 Tesla

Tracker Staging?

	Phase II (MCHF)	Funding (MCHF)	Phase I (MCHF)
Pixels	8.2	8.0	8.2
Inner (Si)	30.5	24.7	25.3
Outer (MSGC or Si)	42.6	34.3	34.4
Gen. Mechanics	6.1	5.9	6.1
TOTALS	**87.4**	**72.9**	**74.0**

Phase II: TDR Design full luminosity, Electronics rad hard CMOS (2.6 CHF/Ch.)
Phase I: TDR Design, staging scenario: stage layers

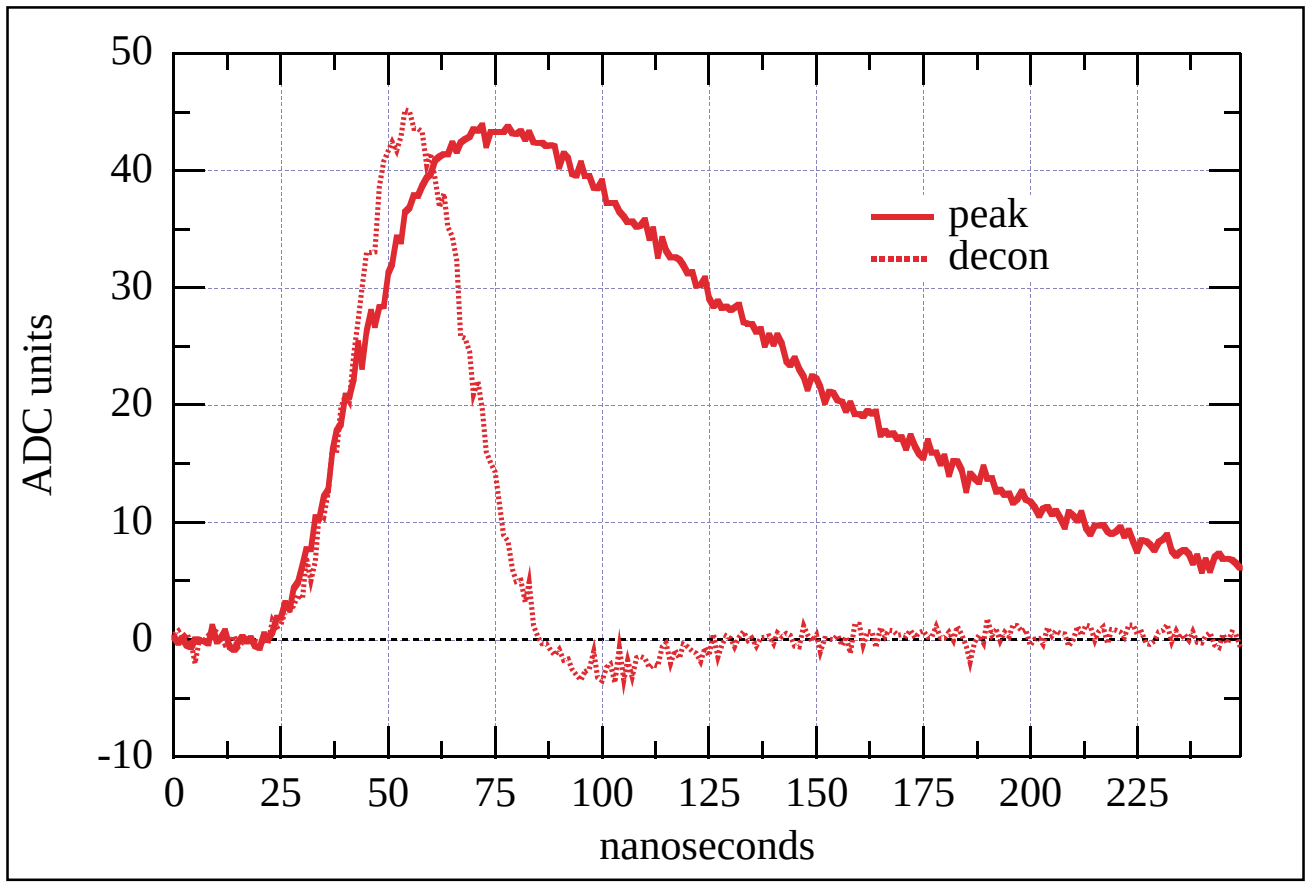
New strategy: Avoid staging scenario.

Reoptimize a one phase Tracker within a cost ceiling of 77.5 MCHF.

- Reduce number of channels by 10% by increasing the pitch.
- Use submicron electronics (2 CHF/Ch.). A full chip in 0.25 μm technology has been received one week ago and preliminary tests are very encouraging. The chip is to be evaluated before end 1999.

APV25: first FE chip in 0.25μm

First chip received 14 October.
Functionality has been successfully tested.
Deconvolution, peak and multisample readout mode working up to 65 MHz.
Next steps: Noise measurements (lower noise expected), Irradiation tests.



Tracker: Path towards Construction

Much progress has been made both on

- Operation of MSGCs and GEM + MSGCs. This will culminate in the PSI Milestone test in November.
- Quality, radiation tolerance and cost of Silicon detectors.

Consider **two solutions** of comparable cost (ceiling of 77.5 MCHF):

Baseline 1: Inner 5 Silicon, outer 6 MSGC layers
Baseline 2: Inner 5 Silicon, outer 5 Silicon layers (All Silicon)

Important Milestones (in bold, Level 2):

- **November 1999:** Robustness test of MSGCs at PSI.

Silicon: Feasibility of large (11 cm), long (16.5 cm), thick (400 µm) detectors (6" technology)
Electronics: evaluation of DMILL and 0.25 µm chips.

- **December 1999:** Decision between Baseline 1 and 2 based on feasibility, schedule, cost and performance.

If the all silicon solution is chosen, an addendum to the TDR must be submitted and approved by the LHCC.

- **January 2000:** Final electronics Preproduction-Review
- **March 2000:** Define Construction Milestones
- **October 2000:** Begin sensor module construction

Hadron Calorimeter: HCAL

HCAL barrel (HB)
EDR November 98. HB procurement in progress (Absorber + Scintillator optics).
EDR for tooling and lifting fixtures, October 99
PPP1 + PPP2, test beam data with close to final electronics (QIE)

HCAL Endcaps (HE)
EDR June 99. Begin absorber production in Belarus.
PPP test beam data with HB and HO.

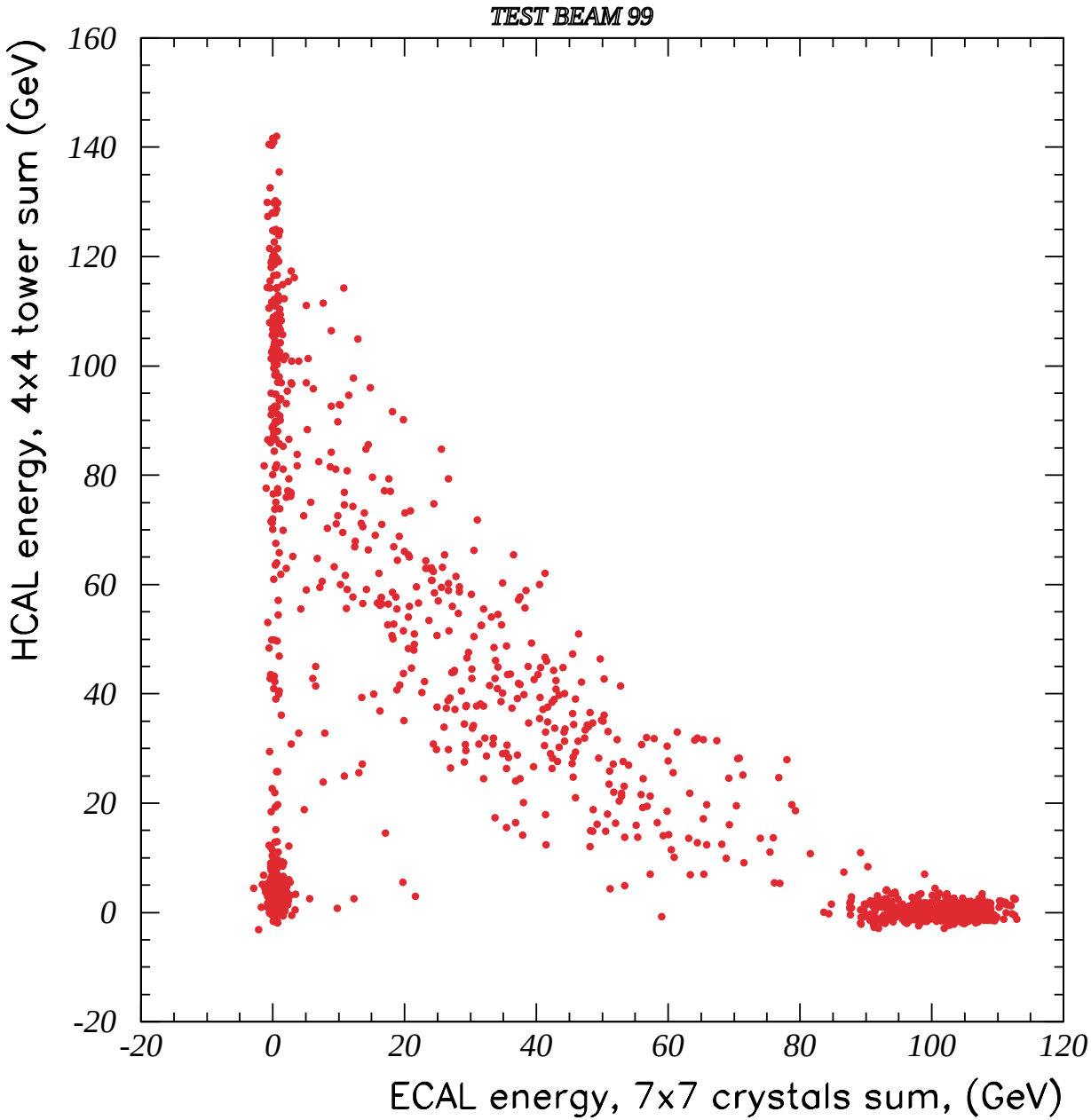
HCAL Outer Barrel (HO)
EDR June 99. Begin optics production in India
PPP test beam data taken.

HCAL Forward (HF)
PPP in test beam in 1999. L2 milestone.
Establish engineering of HF at FNAL.
EDR October 2000

Note: EDR means Engineering Design Review. The EDR has to be passed before launching construction.

HCAL Beam Test Layout

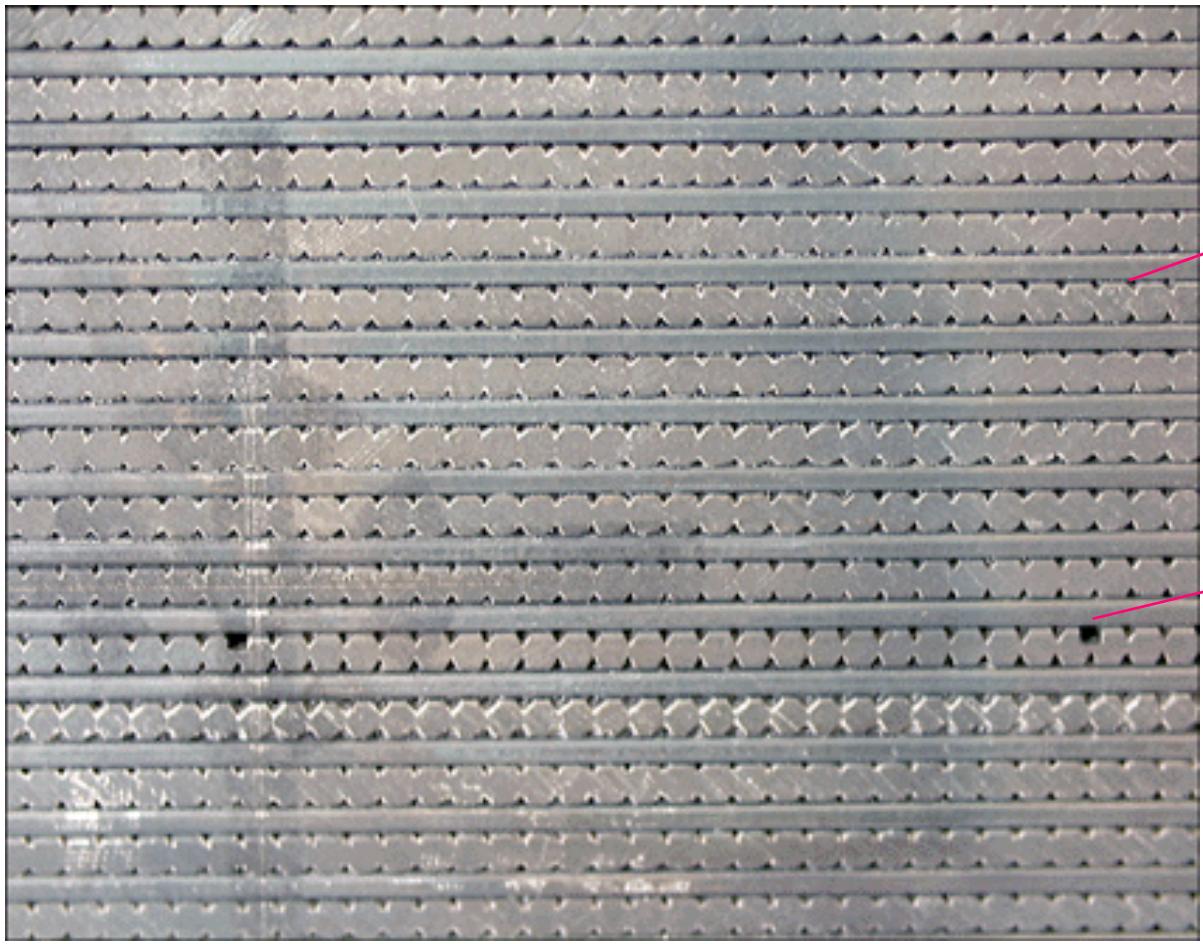
HCAL test beam (Preliminary)



HF Brick (L2 Milestone)

First HF brick fabricated in RFNC-VNIITF, Cheliabinsk (Russia), using diffusion welding technique

HF Absorber Structure



Hole: 0.5x0.5 mm
Quartz Fiber
D = 0.35 mm

Source Tubes

A close-up end view of the HF module shows intereleaved smooth and grooved plates.
The plates are diffusion welded together and each module ('brick') is made of around 100 plates

Electromagnetic Calorimeter: ECAL

ECAL Barrel (EB)
EDR in July 99. Construction of sub-modules has started.
Clarification needed on mechanical tolerance during super-module assembly.
Module 0 (400 channels) prototype for Dec 99. L2 Milestone.
Supermodule 1 complete in June 2000. L2 Milestone.
Test beam data taken with final APDs.

ECAL Endcaps (EE)
EDR in June 2000.
Test beam data taken with 'full-size' VPTs 25mm diameter, with and without preshower in front.

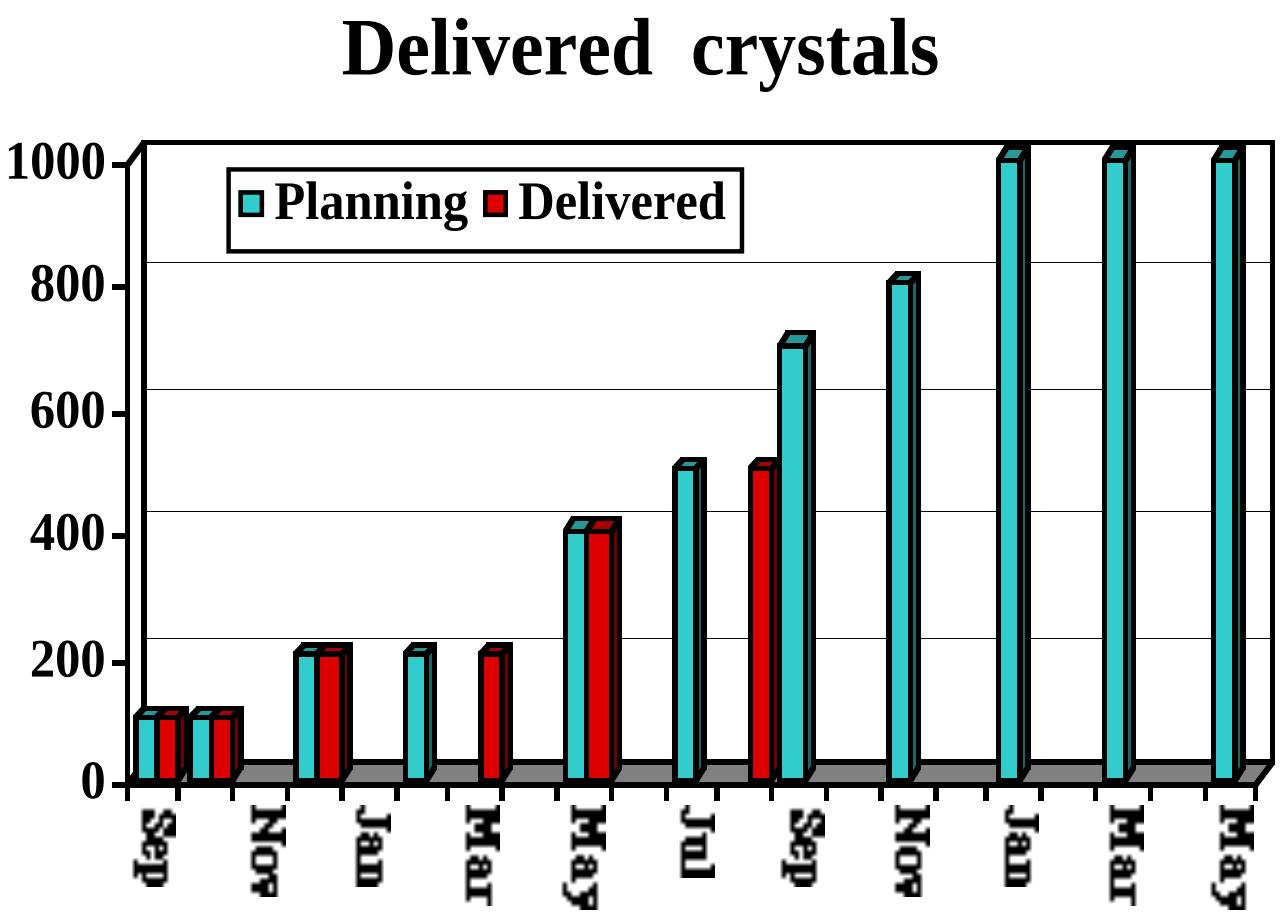
ECAL Preshower (SE)
EDR in October 2000.

Electronics
500 electronics channels test December 99. L2 Milestone. Expect only 200 Channels due to a fault of one of the manufacturers.
Contract for 130,000 APDs signed with Hamamatsu (5.9 MCHF, within estimated cost envelope).

Crystals
Preproduction of 6000 crystals by May 2000 in Russia.
Written statements from both the Russian and Chinese crystal growers within the estimated cost envelope in US $.

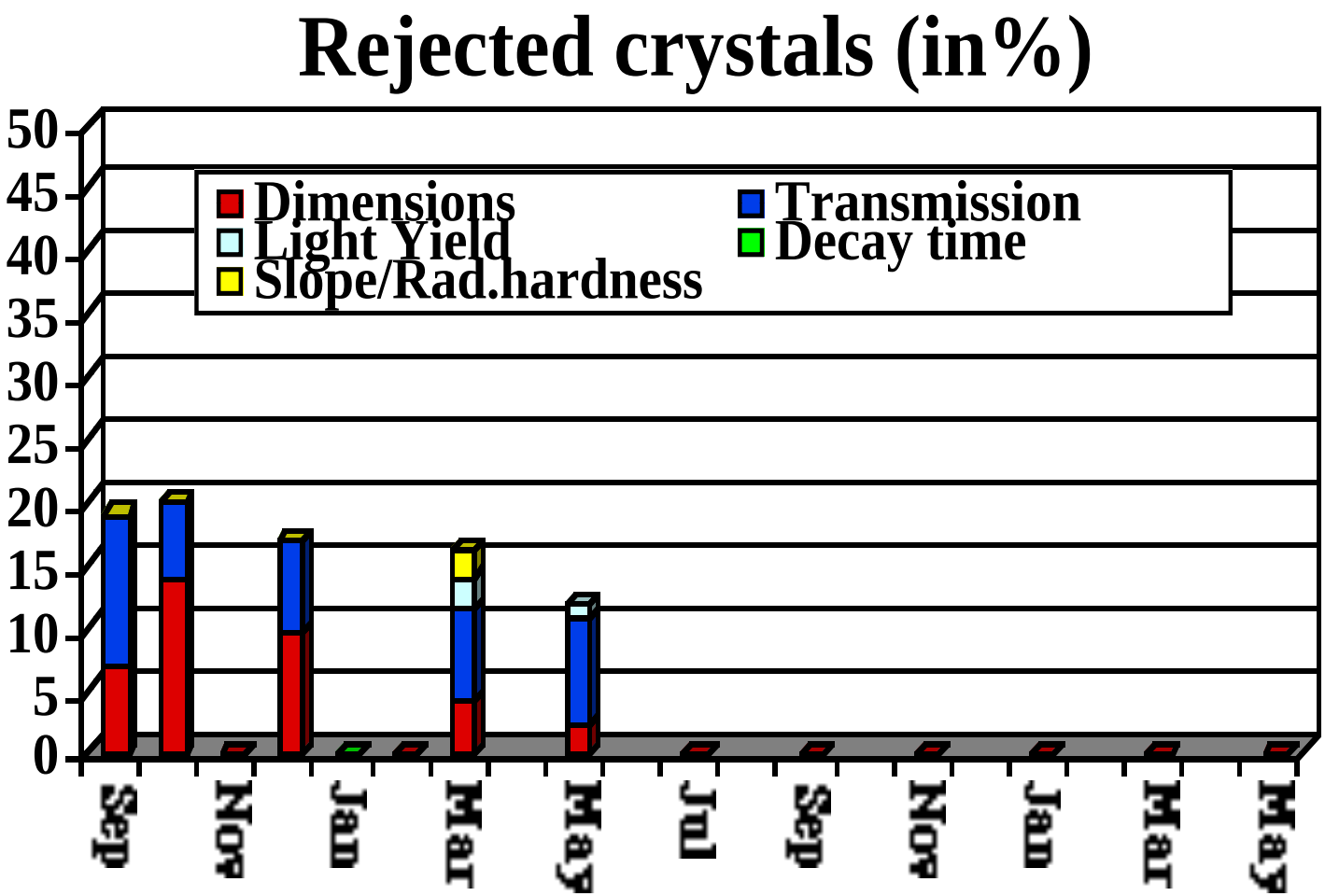
Crystal Production in Russia

1500 crystals delivered by 15 August 1999.
6000 crystals expected by May 2000

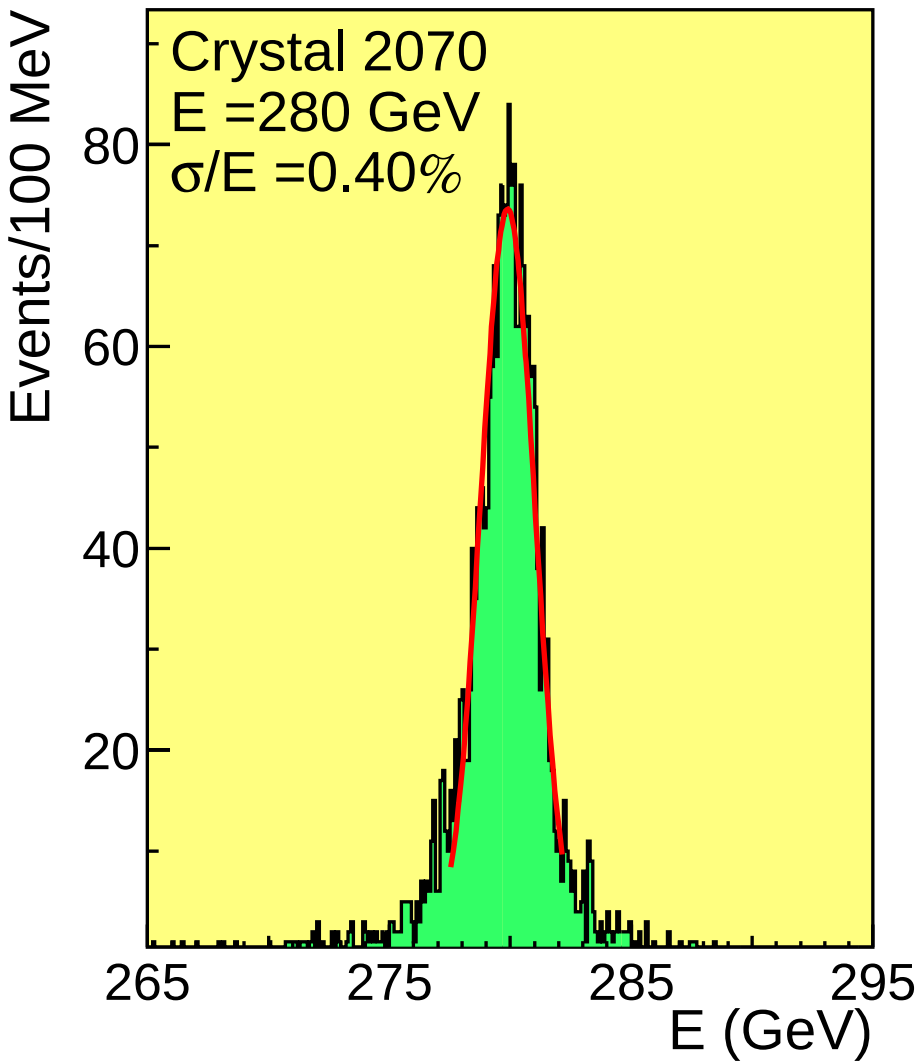


Quality Checks (Russia)

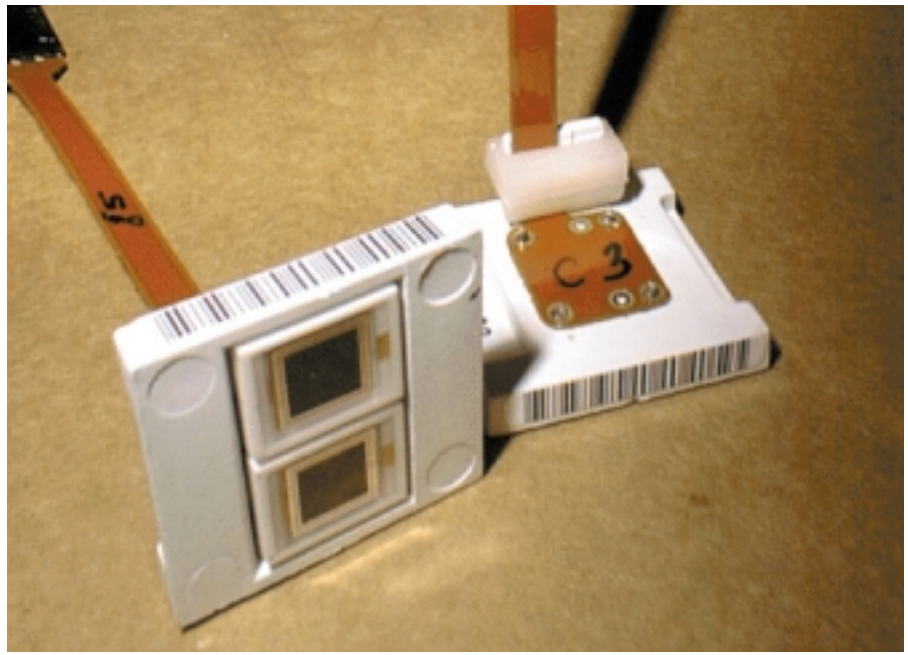
Goal is a production yield of 90% at the factory.

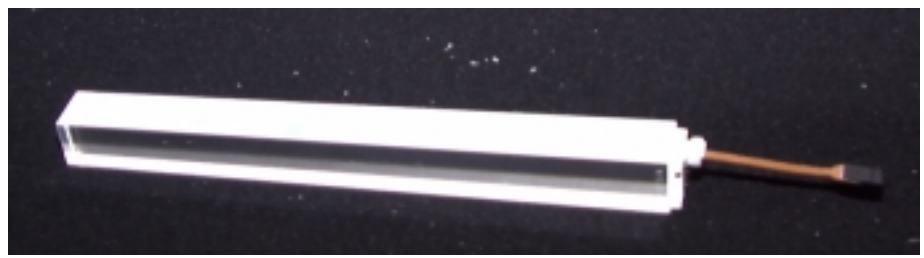


Test Beam Results 1999: Barrel



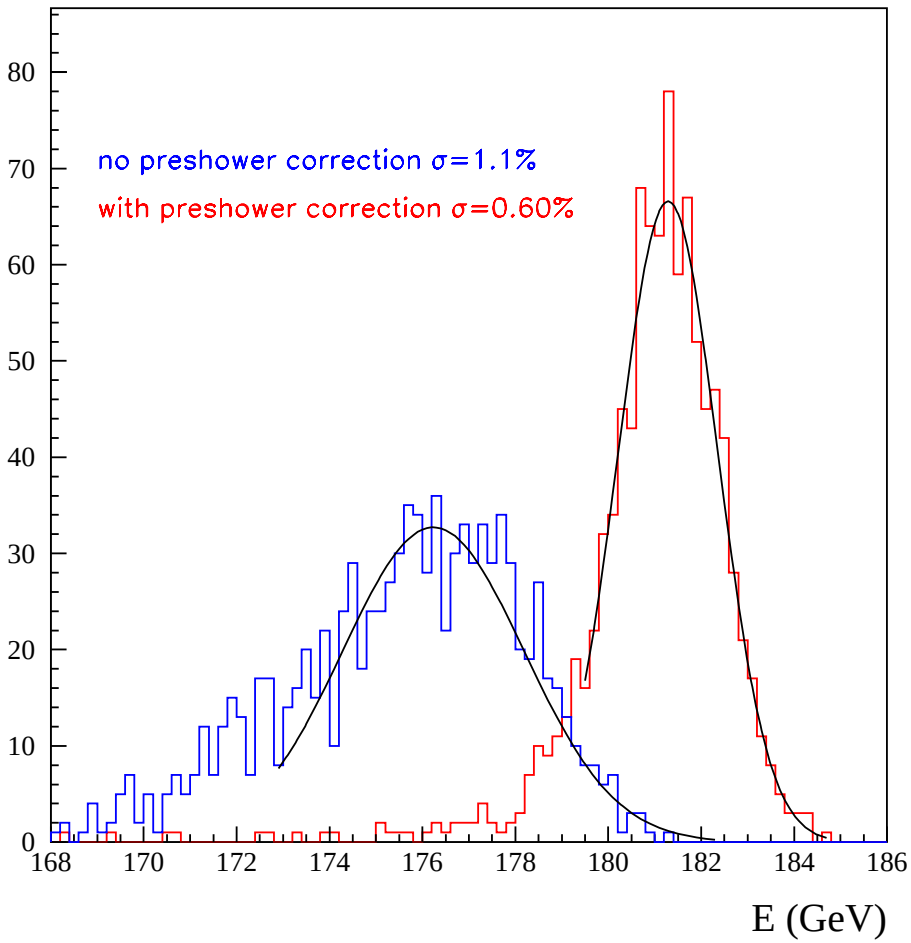
Two APDs 5 x 5 mm surface mounted in a supporting structure (capsule) glued at the rear of the crystal

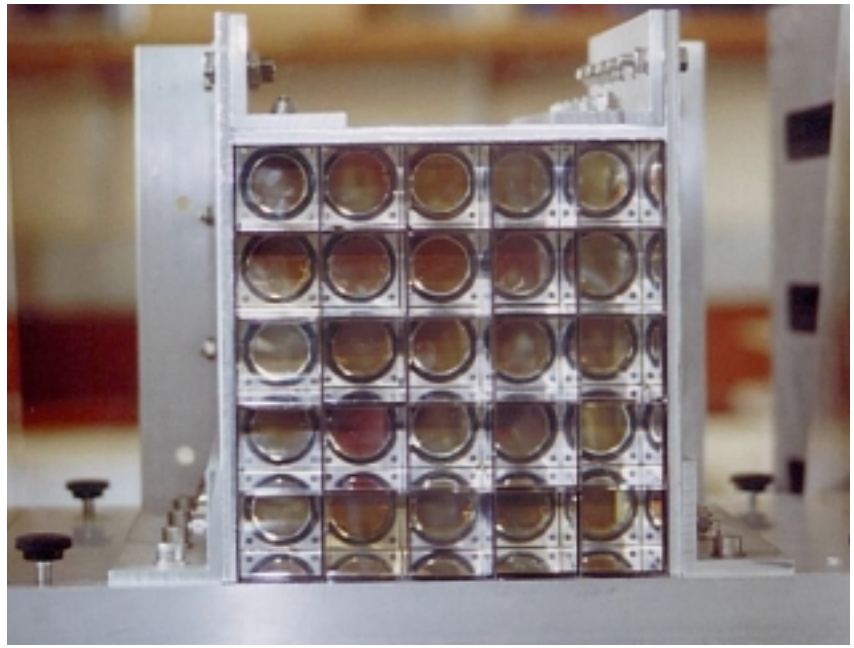




Test Beam Results 1999: Endcap

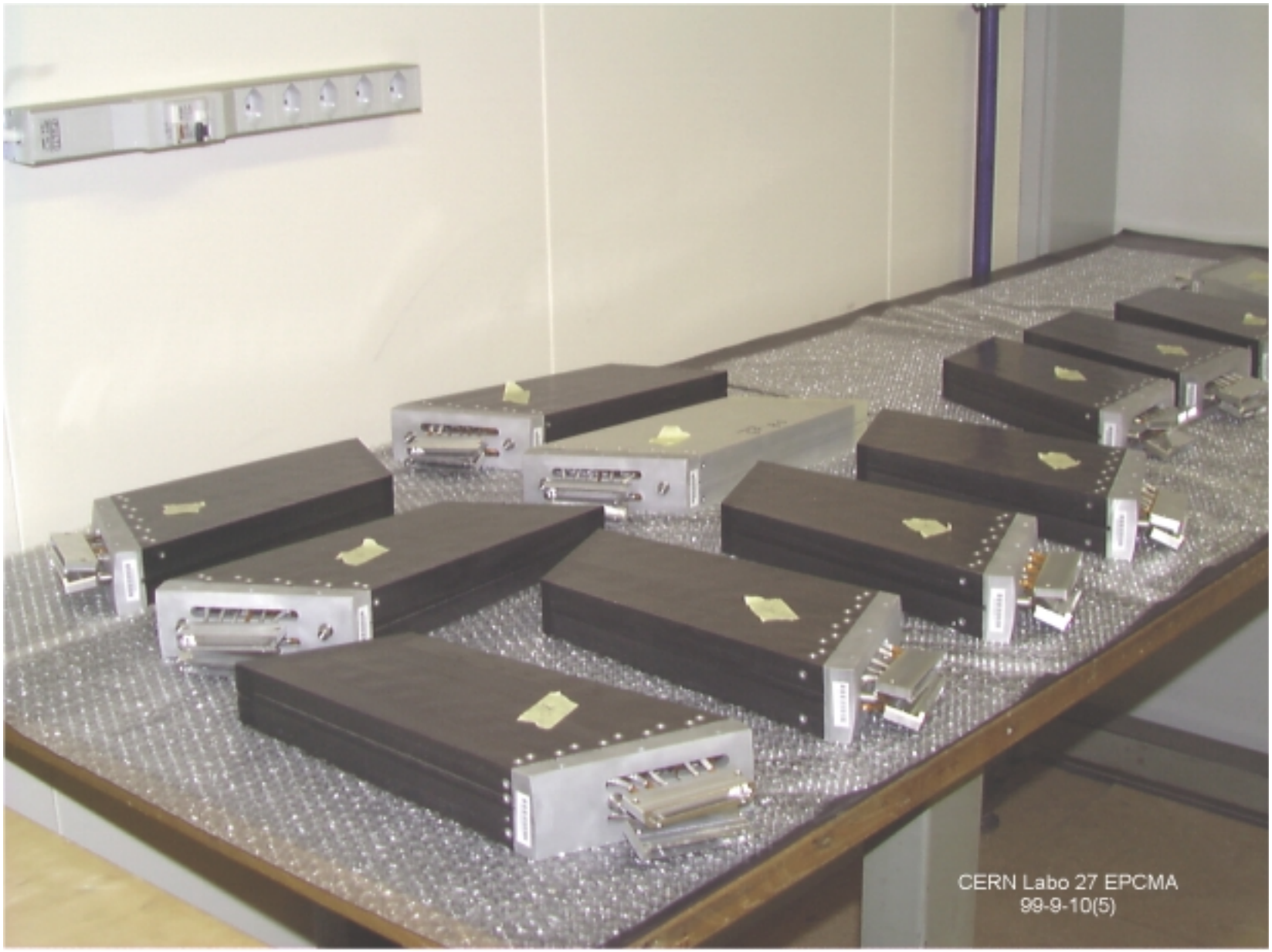
180 GeV Electrons at normal incidence





Module 0 : 400 capsules received

Module 0: 40 Submodules assembled



Muons

Muon Chambers (DTs and CSCs)

Muon Barrel (MB)

EDR in November 98 followed by EDR/2 in June 99. Change of drift cell design for a better mechanical behaviour was approved by EDR Committee and by LHCC. Start manufacture of MB DT chambers in 4 assembly sites (Aachen, CIEMAT, Legnaro, Torino). Test beam data in 99 have validated new design.

Muon Endcaps (ME)

EDR in December 98. Start manufacture of ME CSC chambers in FNAL.
Trigger electronics moved to the iron disk periphery leading to revised cost estimate: Cost increase of 1.7 MUS$ covered by US_CMS contingency. Test beam data in 99 with final prototype.

Muon Endcaps (ME1/1)

EDR in June 99. Start manufacture of ME1/1 CSC chambers in Dubna.

Trigger Chambers (RPCs)

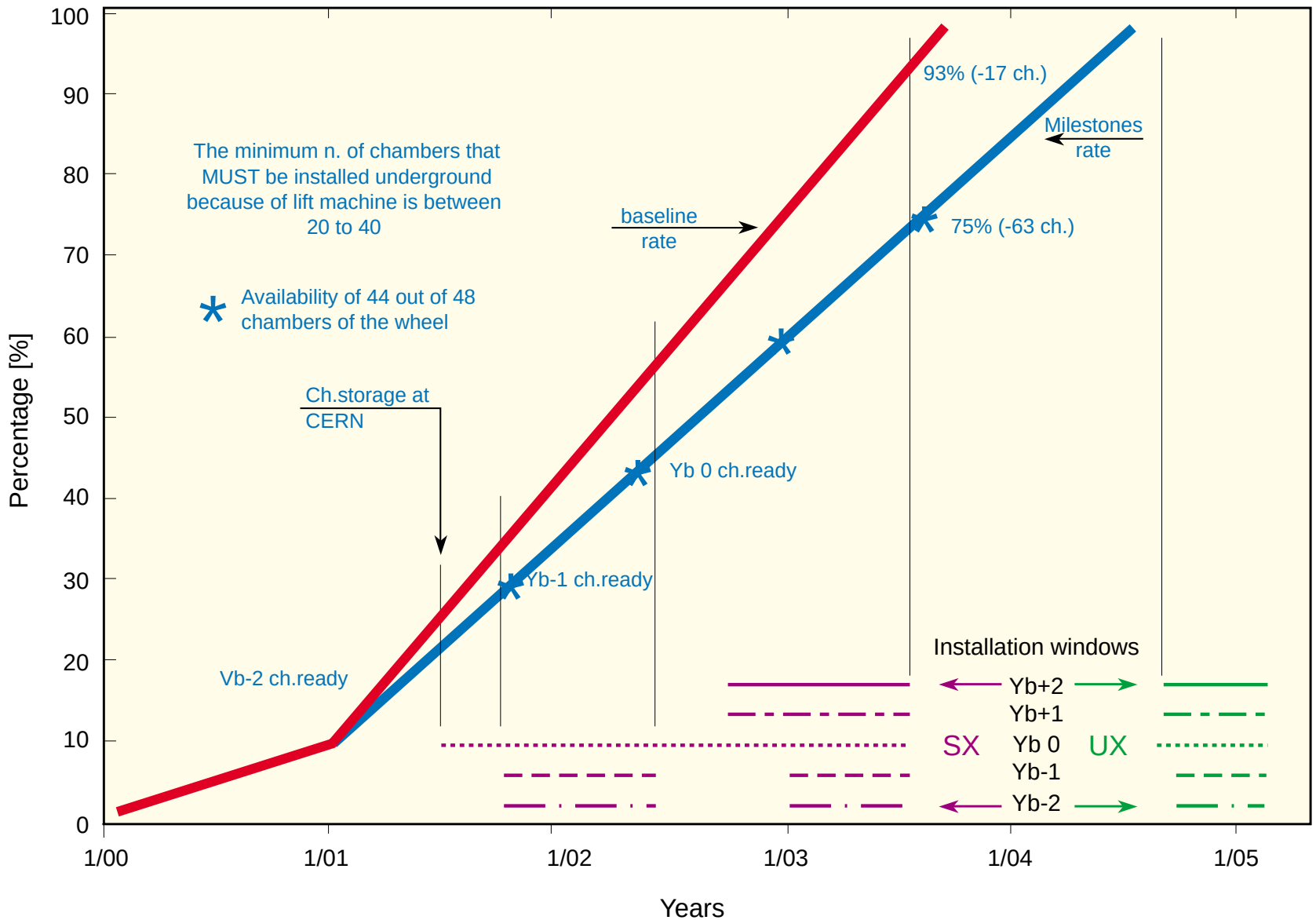
RPCs Barrel (RB)

EDR in June 1999. Start procurement of bakelite panels and single gaps. Assembly in Italy, Bulgaria and China.

RPCs Endcap (RE)

Fix design parameters in December 1999 (L2 milestone)
Manufacturing responsibilities to be clarified: Italy, US, China, Pakistan, Korea?
EDR in 2000?

Muon Barrel Chambers Production and Installation



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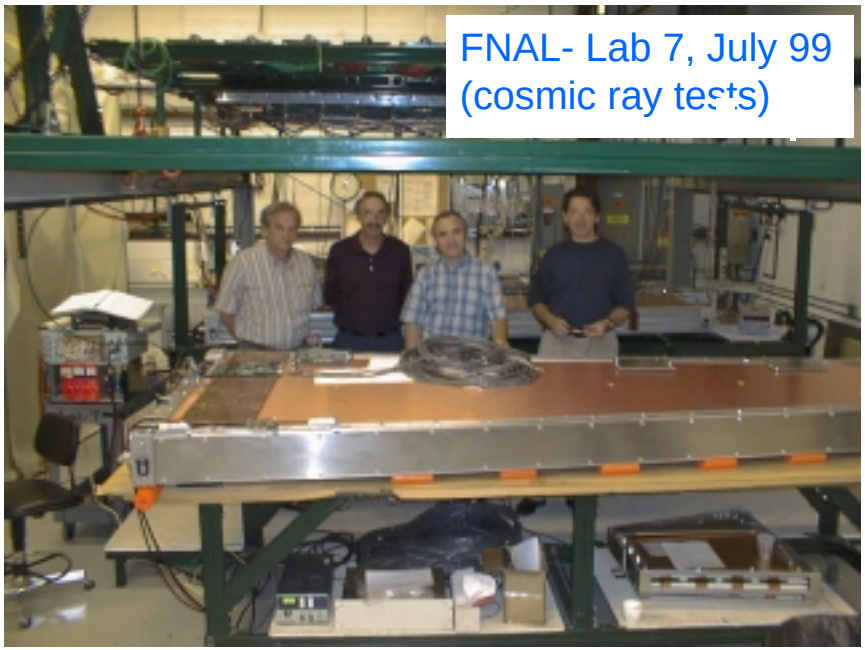
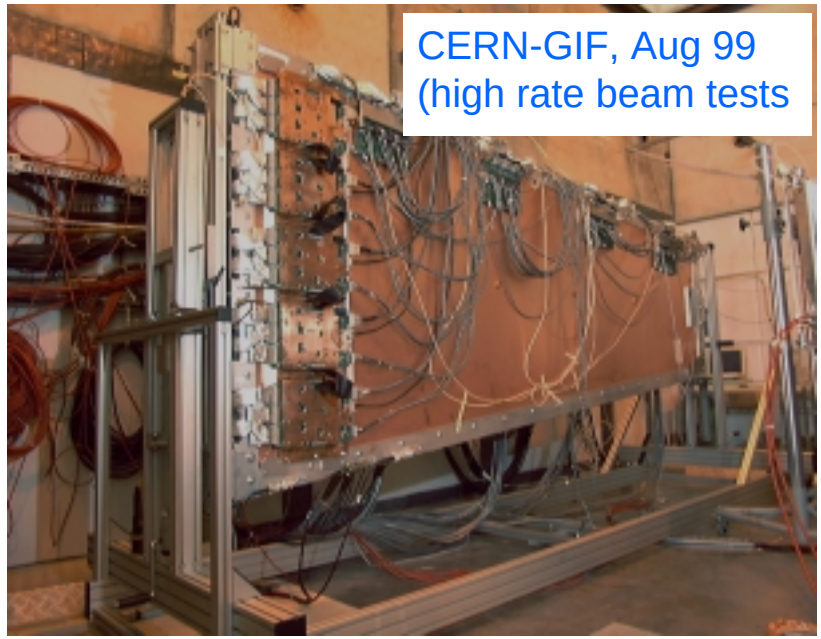
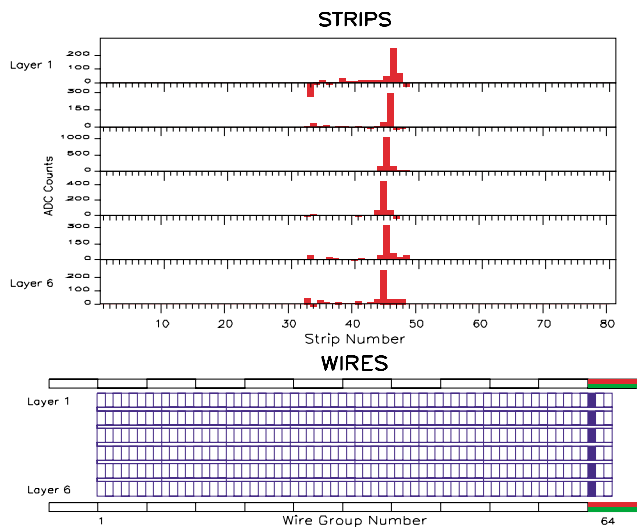
Tests of large CSC prototype at Fermilab and CERN in 1999



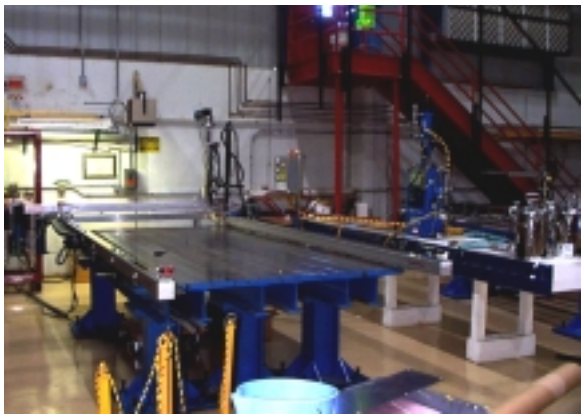




Fermilab CSC factory (MP9 Lab)

Gluing Station

Anode bars, gap bars are glued to panels



Winding Station

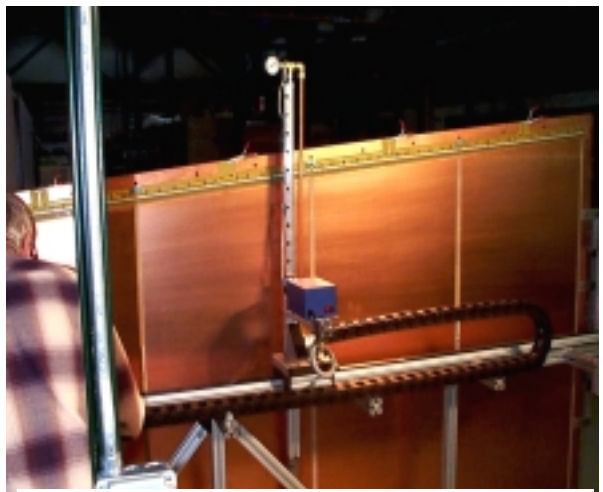
Wires are wound directly on panels

Soldering Station

Automated soldering of wires

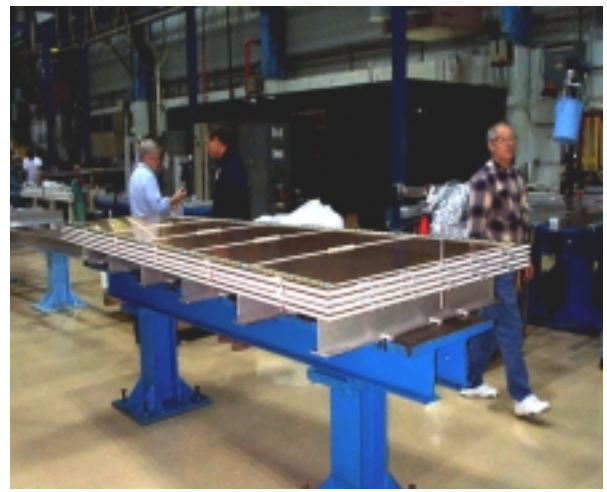
Wire Tension/Spacing Station

Tension and spacing of wires are checked



Ionized Air Knife Station

Dust is removed from wires and panels



Assembly Station

Panels are stacked to make 6 gap chambers

Collaboration Status

Missing MoU Signatures

Korea: Minister has visited CERN, hope for signature before end 1999, but with much reduced contribution w.r.t. MoU (7.2 MCHF→ 2 MCHF)
Hungary: RECFA meeting in Budapest 3-4 September, positive discussions with CERN DG. Signature in 2000?

New Collaborators

Approved as Associated Institutes (June)

Legnaro (Italy)	DAQ developments
SIC Shangai (China)	Crystal R&D
HTTC-RDIPE Moscow (Russia)	HE engineeering

New application as Associated Institute (September)

RFNC-VNIITF Cheliabinsk (Russia)	HF technology development

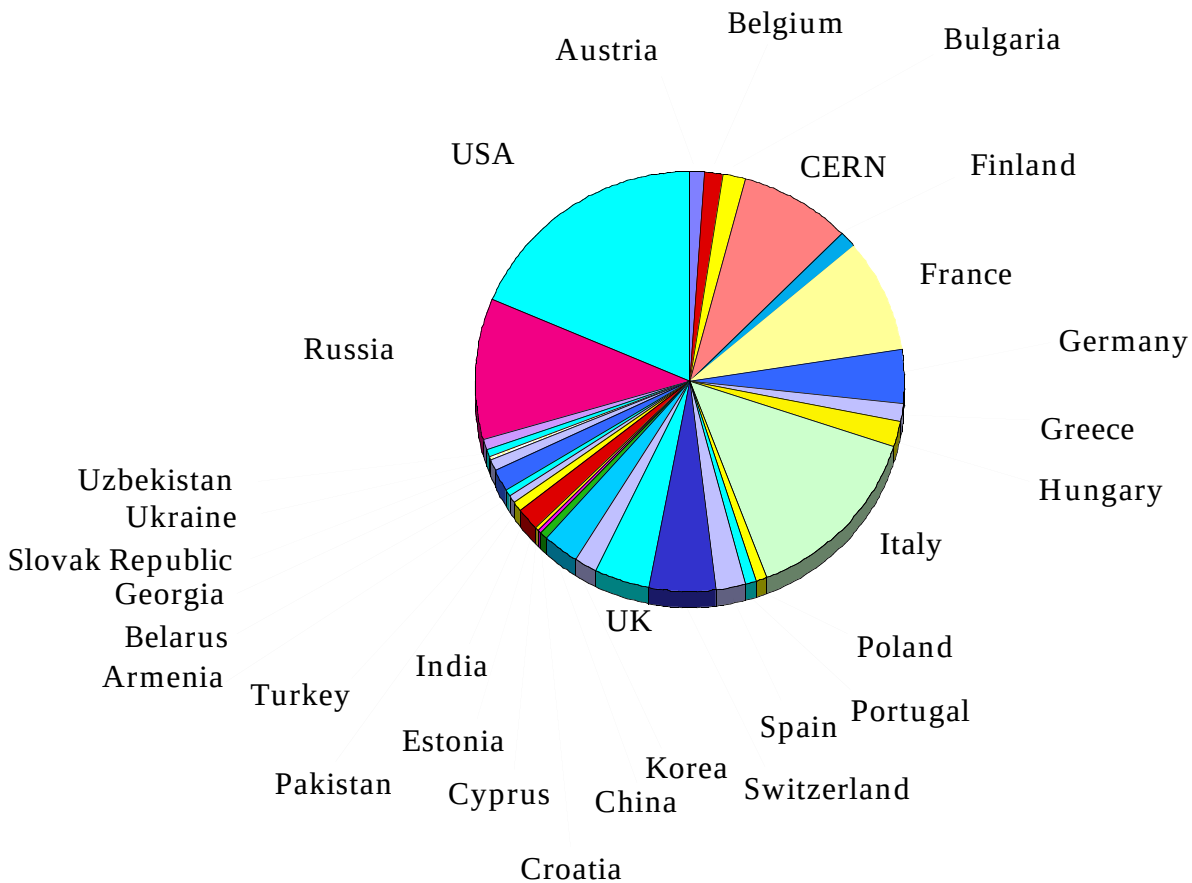
New applications (September)

National Taiwan University, Taipei (Taiwan)
National Central University, Chung-Li (Taiwan)
Bogazici University, Istanbul (Turkey)

The CMS Collaboration

	Number of Laboratories
Member States	60
Non-Member States	51
USA	36
Total	147

	Number of scientists
Member States	1045
Non-Member States	443
USA	334
Total	1822



1822 Physicists & Engineers
31 Countries
147 Institutions

RDMS-Russia Funding

Protocol agreement : Funding plan was 12 MUSD with a flat profile at 1.2 MUSD per year for 10 years. Realistic 1999 funding expectations: 520 kUSD (13 MRR). Plan for 2000: 17 MRR.

Contingency Plan: Define first priority contributions from Russia. Develop a **global Contingency Plan**, which includes **all** potential funding shortfalls.

Item	MoU (kCHF)	First Priority Contribution (kCHF)	Delayed Contribution (kCHF)	Delivered up end 99 (kCHF)	Spent up end 99 (kUSD)	1st Priority Request 2000 to 2004 (kUSD)	
CP	5300.	1400.	3900.	0.	358. (*)	600.	Rotating Shielding
Tracker	1050.	0.	1050.	0.	45.	0.	MSGCs ?
ECAL, EE	2700.	800.	1900.	184.	211.	500.	Alveolar Structure
Presh., SE	750.	750.	0.	35.	39.	400.	Unchanged
HE	4500.	2900.	1600.	1035.	576.	800.	Only 200 t of Brass
HF	2000.	700.	1300.	225.	248.	450.	Bricks Cheliabinsk
ME1/1	3300.	2300.	1000.	148.	155.	800.	Electronics
ME CSCs	1000.	1000.	0.	214.	100.	450.	Unchanged
TOTAL	20600.	9850.	10750.	1841.	1759.	4000.	

(*) 358 kUSD were tranferred from MST to INR, but were lost during the 1998 economical crisis.

Potential Funding Shortfalls

Potential Shortfall or Funding Not Fully Guaranteed (Total = 36 MCHF)

Magnet	**3.9 MCHF**
Barrel Yoke Contract (R)	1.4 MCHF
Dump Resistor (R)	0.3 MCHF
Common Fund (K)	2.2 MCHF
Infrastructure	**2.4 MCHF**
Racks (R)	0.4 MCHF
HF Raiser system (R)	0.3 MCHF
HF Support Table and Shielding (R)	1.4 MCHF
ME4 Shielding	0.3 MCHF
HCAL	**3.6 MCHF**
HE Brass (550 tons) (R)	1.6 MCHF
HF Bricks (R)	0.6 MCHF
HF Fibres	1.0 MCHF
HF Optics, Assembly (H)	0.4 MCHF
Tracker	**6.1 MCHF**
FWD MSGCs (R)	1.0 MCHF
Shift of Funding (I)	0.6 MCHF
Additional Shortfall on New Ceiling	4.5 MCHF

ECAL	**1.8 MCHF**
EE VPTs (R)	0.9 MCHF
Preshower (G)	0.9 MCHF
Muons	**16.2 MCHF**
RPCs, RB (K)	1.4 MCHF
RPCs, RE1/2, 1/3 (K)	0.3 MCHF
RPCs, RE1/1, RE2,3,4 (K)	2.3 MCHF
RPC fwd rev. cost (increase)	1.2 MCHF
ME1/1 Electronics (R)	1.5 MCHF
ME1/1 Remaining Electronics	1.5 MCHF
ME4/1 (US)	2.4 MCHF
ME4/2 (US)	5.6 MCHF
TriDAS	**1.9 MCHF**
DAQ (G)	0.9 MCHF
RPC Trig (K)	1.0 MCHF

G: Greece, H: Hungary, K:Korea, R: Russia
I: India (shift of funding)

Global Contingency Plan:
1) New Collaborators/ Increased Contributions
2) Reimbursement of Russian debts ?
3) Use of existing contingencies in funding
4) Staging items: Clearly extra funding will yield improved exploitation of the detector

List of Items Requiring a Decision

Decision taken for items above the line

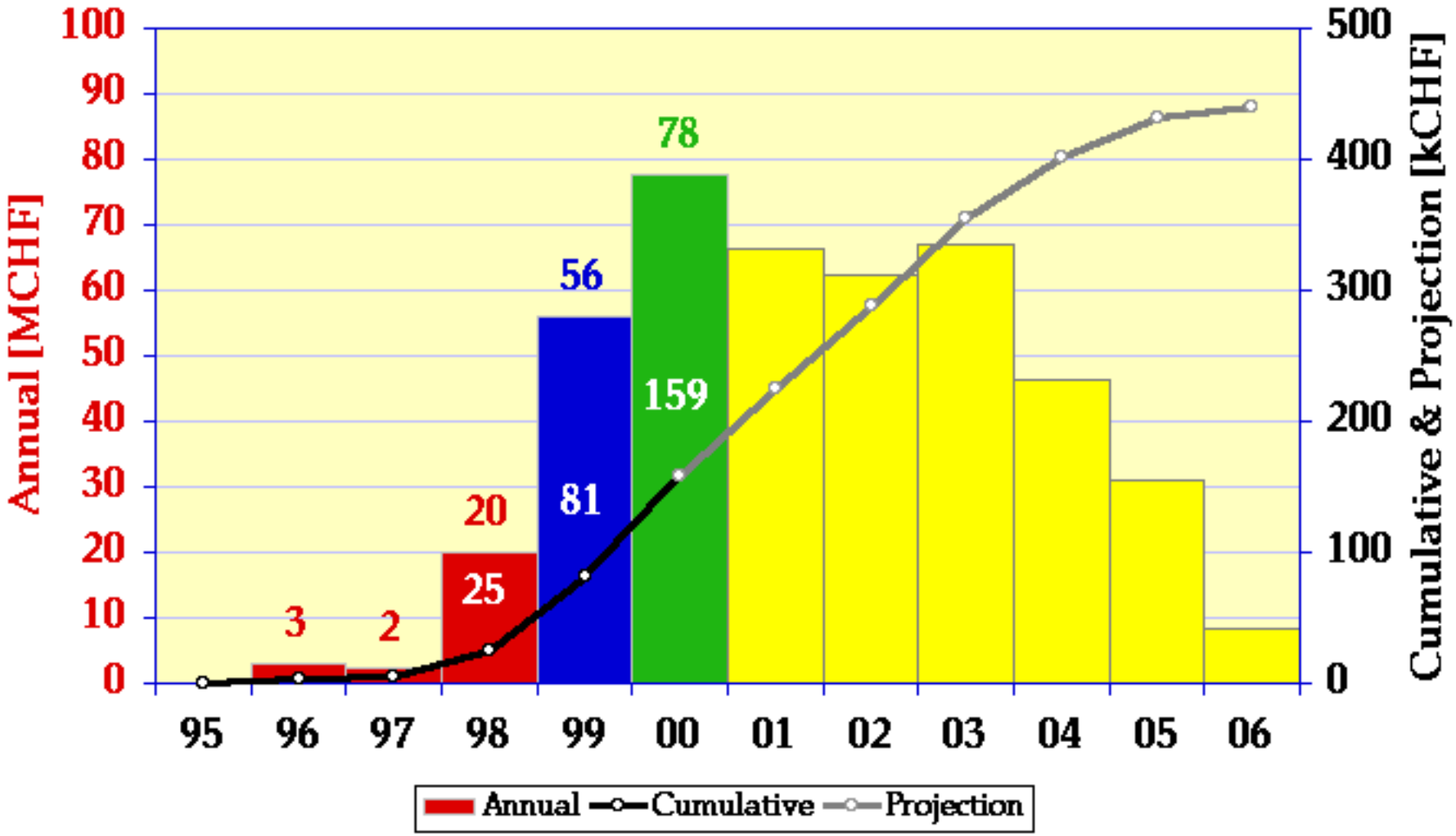
Magnet	Barrel Yoke (R: 1.4 MCHF) (CERN to CF)
	Dump Resistor (R: 0.3 MCHF) (existing reserve)
HCAL	Establish engineering of HF at FNAL
	HE Brass (550 tons R: 1.6 MCHF) (US)
MUONS	RE1/2,1/3: Mechanics+electronics+services (Barrel:0.3 MCHF+China)
	RB (Bulgaria: 0.6 MCHF)

By end-99 prioritize and assign latest date for decision

Magnet
Common Fund (K: 2.2 MCHF)
Infrastructure
HF: Support Table and Shielding (R: 1.4 MCHF)
Racks (R: 0.4 MCHF)
HF Raiser System (R: 0.3 MCHF)
HCAL
HF: Finalize Funding/Procurement Plan
HF Brick procurement (R: 0.6 MCHF)
HF Optics, Fibre procurement (1.0 MCHF)
US Rescope: HF Packing fraction (?? MCHF)
HF Assembly (H: 0.4 MCHF)
US: Rescope: Forward Luminosity Monitor (0.13 MCHF)
Tracker
Tracker MSGCs (R: 1 MCHF): absorb in redesign of Tracker
Shift of Funding w.r.t. MoU (I: 0.6 MCHF)
US Rescope : 3rd Pixel Layer (absorb in redesign of Tracker)
Tracker Redesign (Additional Shortfall 4.5 MCHF)

ECAL
EE: VPTs (R: 0.9 MCHF)
Preshower (G: 0.9MCHF)
MUONS
ME1/1 Front-end electronics (0.5 M$)
ME1/1 Trigger Electronics (1.5 M$)
RE1/1, RE 2,3,4: (K: 2.3 MCHF)
US Rescope: ME4/1 Mechanics and Electronics (2.4 MCHF)
US Rescope: ME4/2 Mechanics and Electronics (5.6 MCHF)
TRIDAS
DAQ: Scale down filter farm (G: 0.9MCHF)
RPC Trigger (K: 1.0 MCHF)

Payments for CMS Construction



First Barrel Yoke Wheel

Magnet Cost

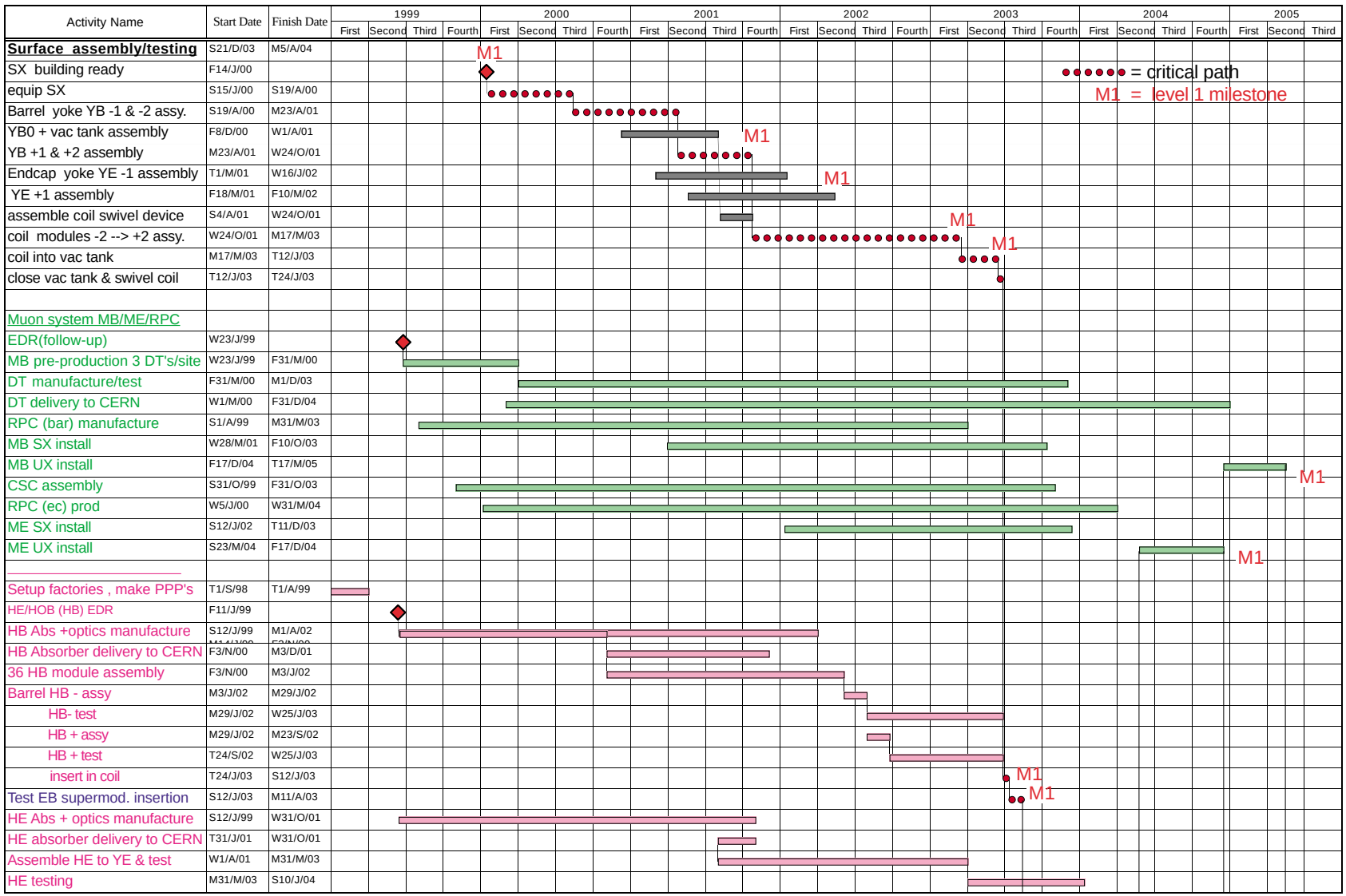
	Cost V9 (MCHF)	Cost V10 (MCHF)	Committed (MCHF)	Not Comm. (MCHF)
Barrel/Vac. Tank	31.2	31.4	27.0	4.4
End-Caps	21.2	15.9	10.4	5.5
Coil	64.7	68.2	31.5	36.7
Installation	4.8	6.3	0.0	6.3
TOTAL	**121.9**	**121.8**	**68.9**	**52.9**

The tender for the winding of the coil (15 MCHF) has been launched in May by INFN. Answers were received on 21st September and are under examination. Contract adjudication before end of 1999. This is a strategic contract as the winding operation is on the critical path.

The magnet project is on budget and on schedule. However the situation will be really understood only after the contract for the winding has been awarded (70% of total magnet cost committed).

Summary Schedule (1)

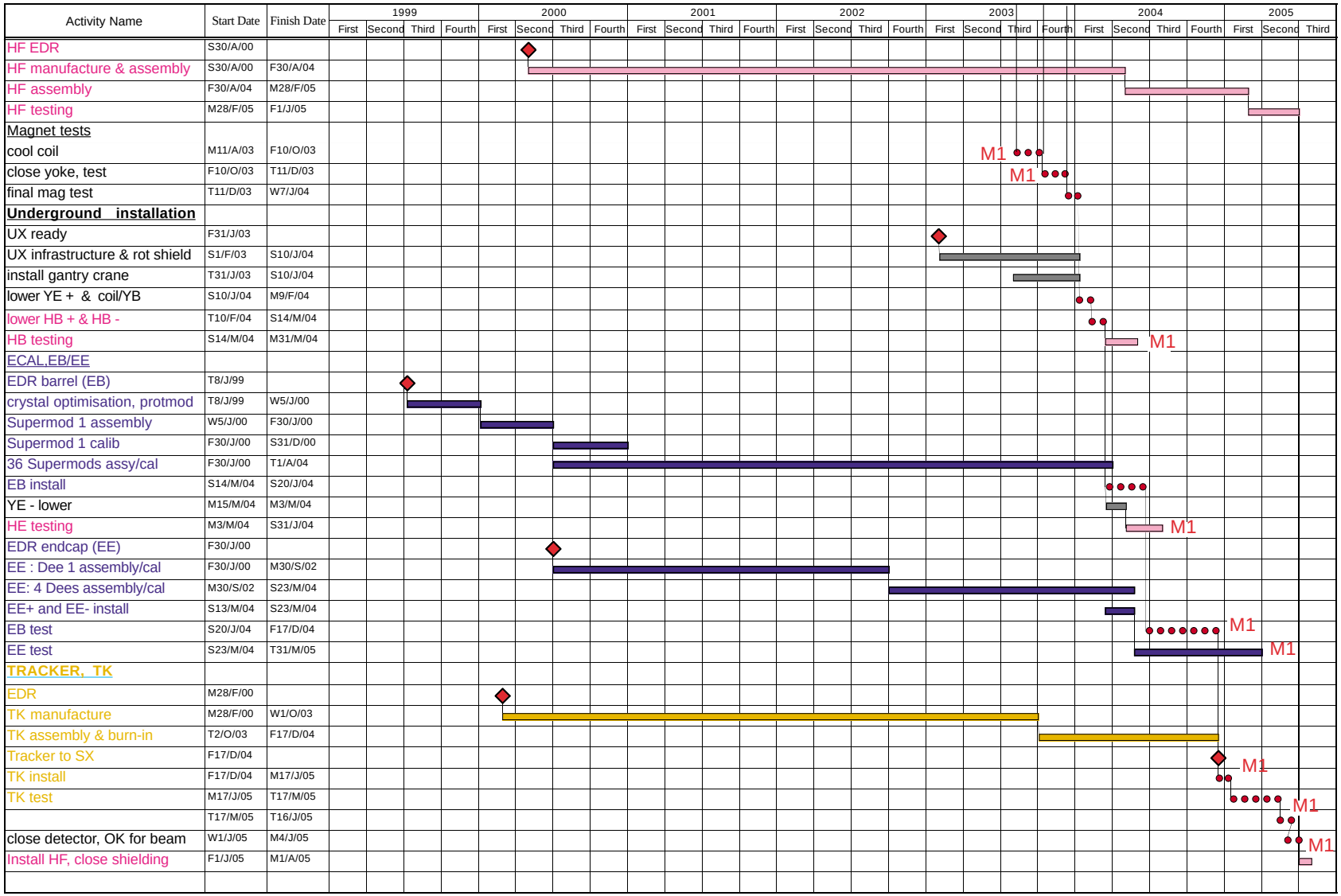
CMS Summary Schedule v 1.0 9'th June 1999 (preliminary)



Activity Name	Start Date	Finish Date
Surface assembly/testing	S21/D/03	M5/A/04
SX building ready	F14/J/00	
equip SX	S15/J/00	S19/A/00
Barrel yoke YB -1 & -2 assy.	S19/A/00	M23/A/01
YB0 + vac tank assembly	F8/D/00	W1/A/01
YB +1 & +2 assembly	M23/A/01	W24/O/01
Endcap yoke YE -1 assembly	T1/M/01	W16/J/02
YE +1 assembly	F18/M/01	F10/M/02
assemble coil swivel device	S4/A/01	W24/O/01
coil modules -2 --> +2 assy.	W24/O/01	M17/M/03
coil into vac tank	M17/M/03	T12/J/03
close vac tank & swivel coil	T12/J/03	T24/J/03
Muon system MB/ME/RPC		
EDR(follow-up)	W23/J/99	
MB pre-production 3 DT's/site	W23/J/99	F31/M/00
DT manufacture/test	F31/M/00	M1/D/03
DT delivery to CERN	W1/M/00	F31/D/04
RPC (bar) manufacture	S1/A/99	M31/M/03
MB SX install	W28/M/01	F10/O/03
MB UX install	F17/D/04	T17/M/05
CSC assembly	S31/O/99	F31/O/03
RPC (ec) prod	W5/J/00	W31/M/04
ME SX install	S12/J/02	T11/D/03
ME UX install	S23/M/04	F17/D/04
Setup factories , make PPP's	T1/S/98	T1/A/99
HE/HOB (HB) EDR	F11/J/99	
HB Abs +optics manufacture	S12/J/99	M1/A/02
HB Absorber delivery to CERN	F3/N/00	M3/D/01
36 HB module assembly	F3/N/00	M3/J/02
Barrel HB - assy	M3/J/02	M29/J/02
HB- test	M29/J/02	W25/J/03
HB + assy	M29/J/02	M23/S/02
HB + test	T24/S/02	W25/J/03
insert in coil	T24/J/03	S12/J/03
Test EB supermod. insertion	S12/J/03	M11/A/03
HE Abs + optics manufacture	S12/J/99	W31/O/01
HE absorber delivery to CERN	T31/J/01	W31/O/01
Assemble HE to YE & test	W1/A/01	M31/M/03
HE testing	M31/M/03	S10/J/04

Summary Schedule (2)

CMS Summary Schedule v 1.0 9'th June 1999 (preliminary)



Milestones (1)

CERN/LHCC 99-26

Milestones CMS Milestones - version 2.0 31'st July 1999

Level 1 Milestones

Surface Hall (SX5) ready	01/00
Underground Hall (UX5) Ready	01/03
Submit Trigger TDR	11/00
Submit DAQ TDR	12/01
End Assembly of Barrel Yoke	06/01
End Assembly of Endcap Yoke	01/02
End Assembly of Coil	02/03
Slide Coil into Vac-tank	04/03
End Assembly of HB in SX5	07/02
End Assembly of HE (on YE) in SX5	05/02
End Trial Insertion of HB in Vac Tank	07/03
End Trial Mounting of EB Super Module on HB	08/03
Start Cool-down of Coil	08/03
Close Yoke, and Start Magnet Test in SX5	09/03
Start Lowering Magnet Parts	01/04

etc. (24 L1 Milestones, 190 L2 Milestones, 216 L3 Milestones)

Milestones (2)

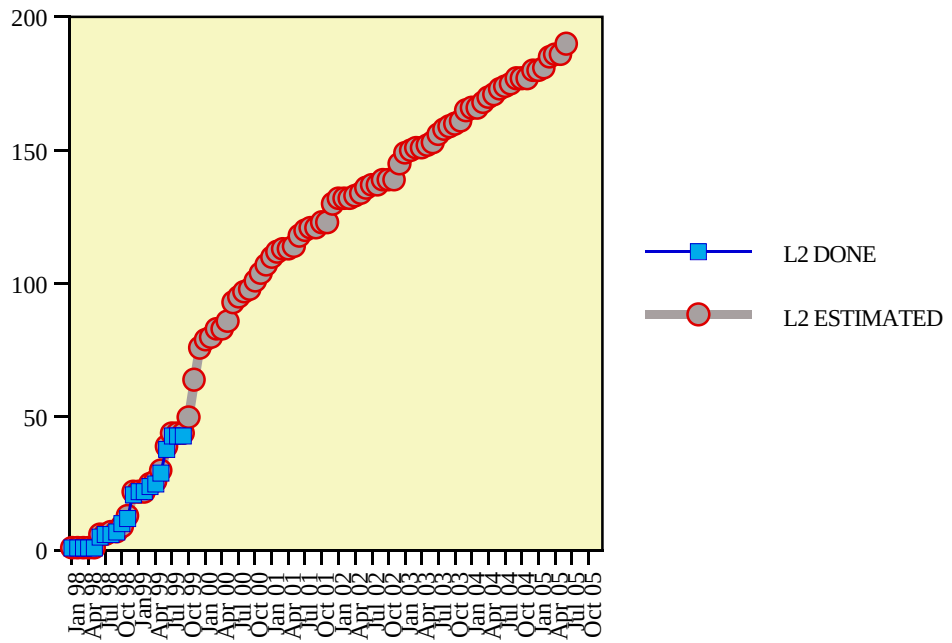
Milestone reporting:

Level 1 : in writing to CMS Steering Committee & LHCC

Level 2 : in writing to CMS Steering Committee & LHCC

Level 3 : verbally to CMS Steering Committee and to LHCC referees by CMS Technical Coordination

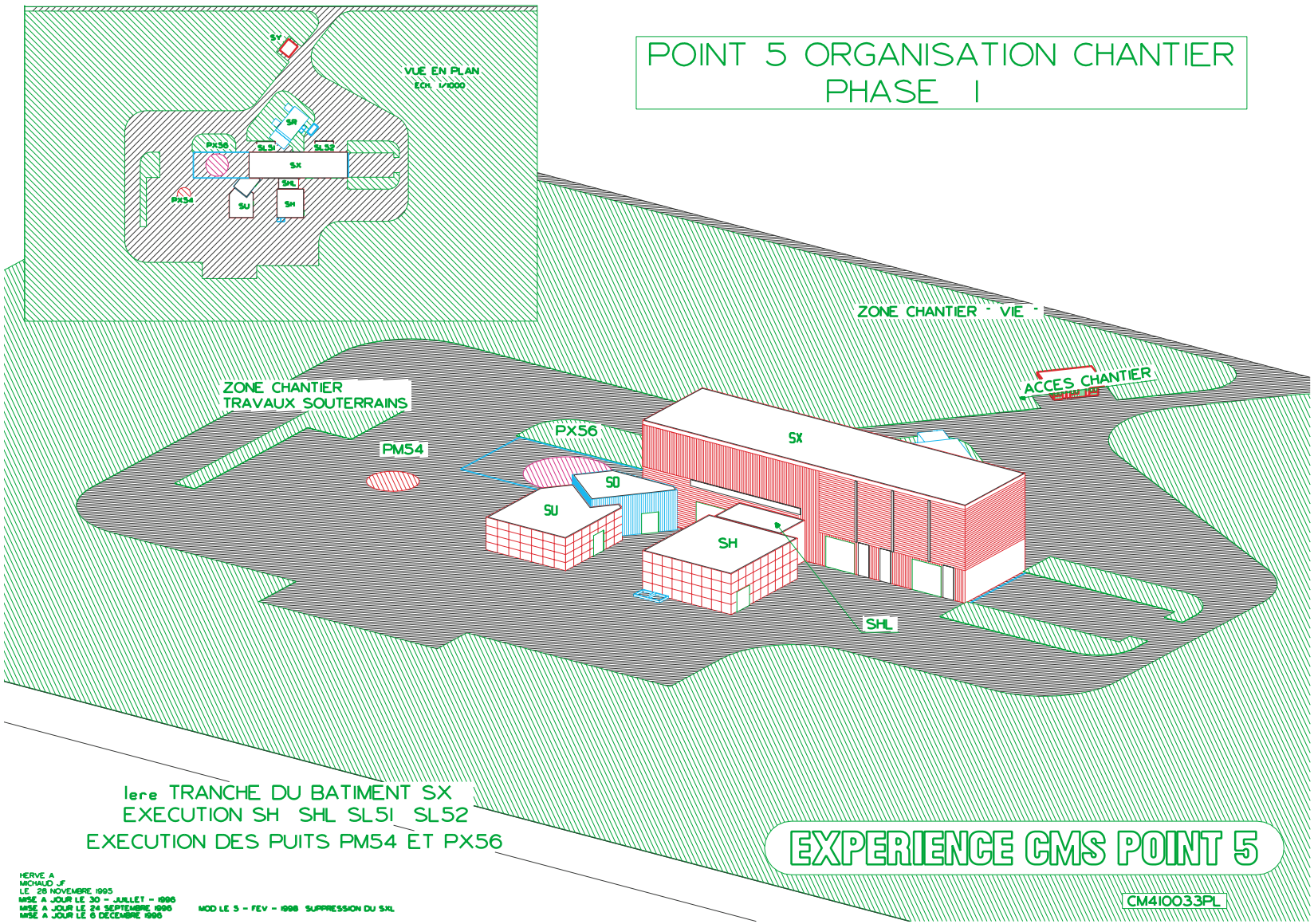
Number of L2 Milestones



Jan 1998 Oct 2005

So far 74 milestones have been passed:
43 Level 2 and 31 Level 3.

Point 5 Design



Point 5


Point 5 - SX5 gantry crane installation - September 17, 1999 - CERN ST-CE


Point 5 - PX56 shaft excavation - September 17, 1999 - CERN ST-CE


Point 5 - SU5 foundations - September 17, 1999 - CERN ST-CE